



The History of Military Mask Filters

Canisters: left, World War I; center, World War II; right, present-day

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The purpose of the protective mask is to form a seal around the face and force the wearer to breathe through one particular hole in the facepiece. To protect the user, the air flowing through the hole must be either supplied or filtered. Since it is difficult to supply clean air in a field environment, the military generally uses filters to clean the air before the user inhales it.

The desire for new and better media for the soldier's mask filter has long been the topic of research. As research found new and better media, filters became smaller and easier to breathe through. In this article, I will discuss the basic theory of air filtration and the history of the U.S. military filters. From copying the idea behind the British small box respirator filter to the latest improvements in filter technology, this article identifies the advances made.

Air Filtration Theory Simplified

Air flowing into the mask has both gaseous and particle components, and the mask filter must clean both. The filtering of gas was the first major concern in gas filtration, so I will discuss it first.

Carbon is one of the first medias used in filters. It, with a large surface area of its volume, is packed in a bed that cleans the toxic gas components of the air flowing through the filter. Carbon filters clean the air similar to the way that sand filters clean water for public consumption. Contaminated air enters from the outside, the contaminants absorb on the charcoal, and the cleaned air passes through. Simple? No. The technology to get the carbon to efficiently clean the air of the maximum

amount of contaminants was long in coming. First, simple charcoal was used, but it was not efficient enough, so it was activated through one of several processes to eliminate any volatile compounds filling pores in the carbon's surface. This maximized the surface area of the carbon particle, therefore, maximizing the capacity of the carbon. This process worked for the organic chemicals encountered, but many of the first agents released were inorganic chemicals.

Inorganic chemicals—like chlorine, the first agent used on a large scale in war—were not absorbed to a large extent on the charcoal and required a reactive filter. Overall, the first masks used in war, like the “black veil respirator,” used reactive filters. The first inorganic and

organic filters used a combination of carbon (for the organics) and soda lime (for the inorganics). Soda lime is a mixture of hydrated lime, cement, kieselguhr, sodium hydroxide, and water. This combination worked well for a time, until the toxic smokes were released.

Toxic smokes released fine particles as fumes and required a different defensive measure—particle filters. Early efforts to stop particles used felt for filtering. This worked acceptably well but was not perfect, so experimentation continued. A good, thick filter paper would filter all particles, but it would increase breathing resistance to an unacceptable level. Later efforts included carbon-impregnated filter paper and then asbestos-impregnated filter paper. After World War II, the asbestos—for health reasons—was replaced.

As time passed, additives were found to enhance the removal and destruction of the inorganics and some highly volatile organics. During World War I, the various types of copper-impregnated carbon were called rankinite, copper carbonite, and whetlerite. Whetlerite was carbon that was activated and then impregnated with

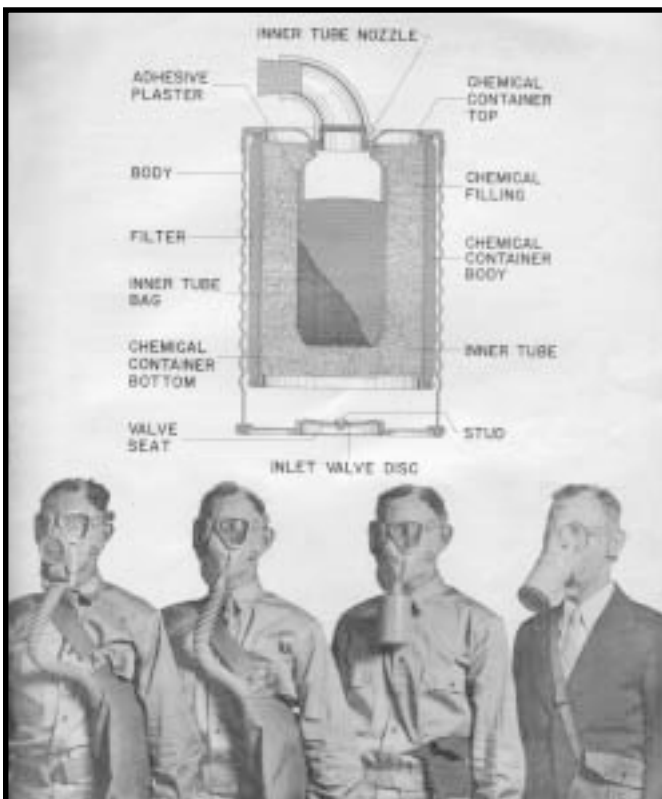
copper through a chemical process. Whetlerite was named after J.C. Whetzel and E. W. Fuller, the scientists instrumental in its development. Tests showed that copper-impregnated charcoal provided twice the protection of regular charcoal against phosgene (CG), triple the protection against hydrogen cyanide (AC), and ten times the protection against arsine (SA). Whetlerite was the most effective impregnated charcoal, and the United States began putting it into some canisters at the end of World War I. By World War II, whetlerite A was the standard filter material—used in an 80 percent whetlerite A and 20 percent soda-lime mixture (called the Type D mixture). By 1942, whetlerite AS was in use with added copper and silver, improving protection against SA. By 1943, chromium VI had been added to make whetlerite ASC, with even better protection against AC and cyanogen chloride (CK). This superior carbon was used until the 1980s when it was determined that whetlerite ASC was hazardous waste. Note that when used properly, it is ok. But, if whetlerite ASC was not disposed of properly, chromium VI pollution resulted. By 1993, the Army had found a suitable nonhazardous replacement—whetlerite AZC—containing zinc. This is the current filling for the protective mask canisters.

World War I

The first U.S. filter canisters in World War I were copies of the British small box respirator filter. Without looking at an actual filter, the United States copied the idea and created the black-painted training filter. The Type A canister was made like the British small box respirator canister, but it was one inch longer due to possibly poor charcoal. It was filled with a mixture of charcoal (60 percent) and green soda lime (40 percent) held in place by terry cloth and gray flannel with two heavy wire screens on the top fastened by two wire springs. The adsorbents were placed in the can in five equal layers, alternating charcoal and soda lime. The canisters were never used at the front and became the so-called training canister.

The Type B canister mixed the two absorbents before filling the canister and provided better protection. This simplified the canister packing. This canister was painted yellow. As time passed, additional changes were made to subsequent models:

- The valve was changed to a removable type.
- Two cotton pads separated the charcoal mixture.
- The color of the soda lime was changed from green to pink.
- The size of the granules changed from 6 to 14 mesh to 8 to 14 mesh.



The diagram in this 1942 document gives a sectional view of the gas mask canister. The principal standard types of early masks shown are, left to right, the diaphragm mask, combat mask, training mask, and noncombatant mask.

The Type J canister, painted green, reduced the volume of absorbent by one-third, cut the life expectancy of the canister in half, but provided at least equal protection during its life. The Type L canister, also painted green, increased the absorbent volume by 25 cubic centimeters to eliminate leakage around an internal cotton pad. The final canister developed during the war, the 1919 canister, was painted blue and used felt to filter the irritant smokes. It was later termed the Mark I (MI) canister. It had two inlet valves on top of the filter protected by a rain shield.

Between the Wars

The MI was followed by the MII and MIII; both had similar dimensions and inlet valves on top. As each model was adopted, each improved the capability and lessened the breathing resistance of previous models. The similar MIIR and MIIIR were identical to the MII and MIII except that the inlet valve was moved to the bottom of the canister.

In 1932, the MIV was the standard filter produced. It had a “sucked-on” cotton linter particulate filter and a mixture of charcoal and soda lime for the media. To make a “sucked-on” particulate filter, air was drawn through the filter’s outlet to draw the cotton fibers to a mesh screen, much like a lint trap in a clothes dryer. There was also a pad at the bottom of the absorbents, follower, spring, yoke, and lugs on the chemical container. A similar filter, the MV, substituted a felt particulate filter for the sucked-on particulate filter. It was considered “substitute standard” and was not produced.

A radical design change resulted in the MVI. This filter used a sucked-on sleeve-type filter with a metal bottom. It contained no pad at the bottom of the



The M1919 (MI) canister and its components

The following is from an unsigned document in the collection of the National Archives. It is a reminder to World War I soldiers to carry their mask with them at all times.

THE SOLDIER'S FRIEND

There are occasions when the best of us are indiscreet, and make mistakes. Sometimes we get away with it, but seldom in France. There is one thing, and only one thing, that can save us our present and future health, the health of our descendants, and in many cases, our own lives. This is not a new thing I am to tell you of; all of you know of it, and many of you have already used it. A great many of our first troops over here thought it unnecessary, and completely neglected to use it, or used it improperly, with the result that hundreds of them are in hospitals, suffering terribly, many of them totally disabled for future service; causing the government much trouble and expense, when it should and could have been avoided. It was not because they did not know of the necessary precaution, but because they did not realize its value.

Soldiers, inexperienced in its proper use, have neglected this vital protection, hoping to “get away with it,” or to get immediate medical treatment. “An ounce of prevention is worth a pound of cure,” but in this case the cure may be of little assistance.

You have undoubtedly been warned that there are certain things to be carefully guarded against “over there.” I now want to emphasize one of these. It is impossible to exaggerate its danger. Every man, temporarily or permanently, unable to “carry on” is aiding the enemy.

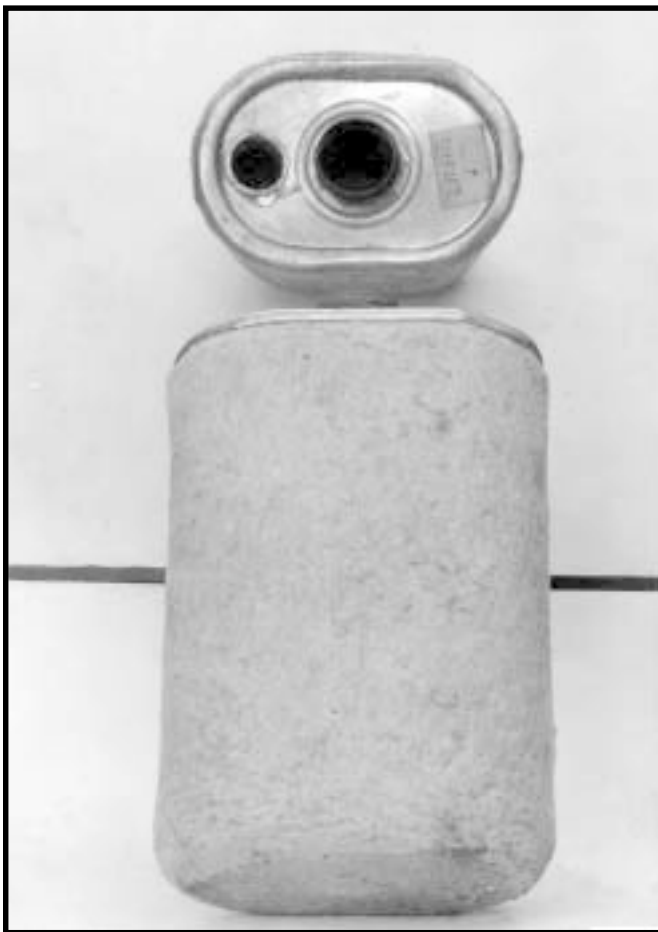
There is one, and only one sure protection, and that is—The Soldier's Friend. You have heard of the Soldier's Friend. It is well known to the soldiers in America, but it is far more popular here. This little precaution may cause slight inconvenience, but you get full, free movement when it is properly adjusted. It is slightly difficult to wear but practice makes one very efficient in its use. Examine it frequently to be sure there are no holes in it. Stretch it to see that the rubber has not rotted. Try it on. Make sure that it fits. If there is anything wrong with it, get another.

And men, never misplace it. It may be dangerous to be without it, so, when you promenade with Mademoiselle, take it along. Inspect it regularly. Be sure that it is always in good condition, ready for immediate use. You can never tell when you will have to use it. Never be without your Soldier's Friend.

The Soldier's Friend is his Small Box Respirator.

absorbents, follower, spring, yoke, or lugs on the chemical container. The bottom of the canister actually contacted the absorbents and was supported by lugs in its body. The MVII was similar to the MVI but used a cup filter and an integral bottom for the container. Both proved effective in experiments; however, neither was produced. The MVIII was the next major filter canister produced.

The MVIII was similar to the MVI but had a multi-layer particulate filter. The MIX was designed to facilitate mass production. It was slightly shorter than the MVIII and had smooth sides. It was filled with Type D filling and had a cotton particulate filter impregnated with lamp black. The MIXA1 used a larger (2-inch diameter) inlet and had a corrugated canister. The particulate filter was upgraded to a cellulose filter with asbestos. The MIXA2 used Type ASC charcoal and was identified by its yellow top. Tests showed that adding soda lime was unnecessary, so it was deleted. The MIXA2's defense against CK was the best ever of any U.S. filter, and because of concerns that the enemy might use CK, more than 1.2 million canisters in gas masks were changed out with the forces in the field.



The MIV canister without a canister body

Adopting the lightweight protective mask early in World War II was partially the result of adopting an effective lightweight canister. Lightweight mask and canister experiments in the 1930s ultimately resulted in the design and adoption of the M10 canister. The M10 was designed as a radial flow canister, which meant that while the air was drawn in through a hole in the bottom, the air flowed up the sides of the can and flowed in from the sides to the center along the radius of the cylinder. Through the adoption of the ASC charcoal, the filter could be constructed smaller and still have sufficient protection for field use, so it was adopted in 1942. The M10A1 was similar but contained more charcoal.

World War II

During World War II, the M2 training mask was actually issued as an emergency measure for soldiers to use as a service mask before issuing the M5 assault mask. It was particularly popular with jungle fighters in the Southwest Pacific area and with many of the airborne units. The M2 training mask used the MI training filter, containing whetlerite A. When whetlerite ASC charcoal was developed, the MIA1 training filter, containing whetlerite ASC, was issued to replace the MI training filter for use in combat.

In World War II, along with the development of the M5 assault gas mask, the Army developed the E3 combat canister. This was an axial flow filter—air flowed through the can along the axis of the cylinder. It was originally made of steel components and weighed 350 grams. Subsequent to standardization as the M11 canister, the canister was redesigned with aluminum components. All originally produced steel canisters were not shipped overseas with M5 masks because of concerns about peripheral air leakage, but the steel cans were held for issue to the M8 snout-type mask. At least 1,388,246 canisters were held



Comparison of the M11 canister (left) to the standard C2 canister (right)

in storage into the 1950s. Many of the steel canisters were issued to the Office of Civil Defense for use with the snout-type M16 (CD-V800) mask.

After World War II

At the end of World War II, the Army had three standard filter canisters for general use—the MIXA2, the M10A1, and the M11. In 1948, the M2-series masks were declared obsolete and the MIXA2 was removed from the inventory. This left the M10A1 and M11 as standard, and they remained standard for the next 40 years. The canister of the 1980s was pretty much the same as the 1940s, except for the minor addition of a charcoal filter to prevent media leakage.

In the 1950s, the Army experimented with a variety of masks testing various filter technologies. The E13-series masks tested various configurations. The E13R4 mask had integral cheek-mounted filters, so it did not require a separate filter. The final mask, adopted as the M17, was a slightly modified E13R10, with the soon-to-be-famous M13 filters mounted in the cheeks. These filters were not usable in any other mask and were famed as the so-called “pork-chop-shaped” filters using a lightweight gas-aerosol filter material. The filters could only be changed from the inside, and even then with difficulty. The original M13 filters had a problem with contamination ruining the charcoal media and were quickly replaced by the M13A1. The M13A1 was replaced in 1968 by the M13A2 filters. Thereafter, the M13 and M13A1 filters were known as so-called “training filters” and were recognized by either a black (M13 and early M13A1) or gold (M13A1) inlet ring. The M13A2 has a green inlet ring.

With the initiation of the XM29 mask program, by international agreement, the Americans were to develop the mask and the Canadians were to develop the filter. The Canadians quickly developed the C2 filter as their part of the bargain. It was a filter roughly similar in size to the M11 but with a NATO standard 40-millimeter filter thread to screw into the facepiece. Like the M11, the air passed first through a pleated or accordion-style particulate filter and then through a layer of impregnated charcoal before passing to the user. This filter was used in all mask programs in the 1970s and afterwards until the Joint Services General Protective Mask (JSGPM) Program.

When whetlerite ASC charcoal was required to be disposed of as hazardous waste, the Army developed the C2A1 canister using whetlerite AZC charcoal. The C2A1 canister had fewer disposal restrictions than the C2 canister.



M11 (left), C2 (right), and the M13 “pork-chop-shaped” filter (center)

As noted, the JSGPM is attempting to push filter technology to new levels of effectiveness. Filters are being designed to maximize effectiveness while minimizing interference with the user. Much more on this exciting program will follow.

The Future

As we have not yet developed the ultimate filter, more will come. An interesting technological development would be the creation of a filter that causes the catalytic destruction of the contaminant instead of adsorption. When this is successfully militarized and fielded, our soldiers would have a filter that never needs replacing. Who knows what technology will bring for the transformed force?

Conclusion

The Army’s filter canister program has provided much of the impetus to the Army’s protective gas mask program. Through the development of improved filter media, the filters gradually became lighter with similar protection to their predecessors. As the filters became lighter, the masks became lighter as well. The JSGPM is again pushing technology to ensure the best protection for our soldiers in the years to come.

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